

I CLAIM AS MY INVENTION:

1. A magnetic resonance tomography apparatus comprising:
 - a basic magnetic field system which generates a static basic magnetic field having a volume adapted to receive a subject containing different nuclei which, when excited to produce precessing nuclear spins, respectively represent a first spin ensemble and a second spin ensemble having respective steady state signals associated therewith;
 - a gradient coil system which emits gradient pulse trains respectively for a slice selection gradient, a phase coding gradient having a phase coding direction, and a readout gradient;
 - a radio-frequency system which emits RF excitation pulses to excite said nuclear spins and which, under said readout gradient, receives said respective steady state signals; and
 - a sequence controller which operates said radio-frequency system and said gradient coil system to generate a FISP pulse sequence in said volume, said FISP pulse sequence including a plurality of RF excitation pulses separated by respective repetition times, with each repetition time being incremented relative to an immediately preceding repetition time by a phase angle increment, and with respective flip angles $\leq 90^\circ$ that alternate in sign from excitation pulse-to-excitation pulse, so that said steady state signals have respective signal polarities with a relationship selected from the group consisting of identical signal polarities and opposite signal polarities, and wherein said FISP pulse sequence further includes respective phase coding gradients that alternate as to said

phase coding direction from repetition time-to-repetition time, and completely balanced gradient pulse trains within each repetition time.

2. A magnetic resonance tomography apparatus as claimed in claim 1 wherein said first spin ensemble has a first precession angle associated therewith and wherein said second spin ensemble has a second precession angle associated therewith, and wherein said sequence controller selects said phase angle increment so that said first and second precession angles satisfy respective mathematical conditions for a selected one of said signal polarity relationships.

3. A magnetic resonance tomography apparatus as claimed in claim 1 wherein each of said steady state signals is referenced relative to a zero-axis, and wherein each steady state signal exhibits zero-axis crossings, and wherein said sequence controller selects said phase angle increment to maximize a difference angle between closest respective zero-axis crossings of the respective steady state signals.

4. A magnetic resonance tomography apparatus as claimed in claim 1 wherein said sequence controller operates said radio-frequency system to excite water nuclei as said first spin ensemble and fat nuclei as said second spin ensemble.

5. A magnetic resonance tomography apparatus as claimed in claim 1 further comprising an image computer connected to said radio-frequency system for obtaining and storing a first image dataset when said polarities are identical and for obtaining and storing a second image dataset when said polarities are opposite.

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6. A magnetic resonance tomography apparatus as claimed in claim 5 wherein said image computer generates a pure image of a selected one of said first spin ensemble and said second spin ensemble by combining said first and second image datasets by operations selected from the group consisting of addition and subtraction.

7. A magnetic resonance tomography apparatus as claimed in claim 1 wherein said sequence controller generates each phase angle increment as one-half of the phase angle increment of the immediately preceding repetition time.

8. A method for operating a magnetic resonance tomography apparatus comprising the steps of:

generating a static basic magnetic field having a volume adapted to receive a subject containing different nuclei which, when excited to produce precessing nuclear spins, respectively represent a first spin ensemble and a second spin ensemble having respective steady state signals associated therewith;

providing a gradient coil system which emits gradient pulse trains respectively for a slice selection gradient, a phase coding gradient having a phase coding direction, and a readout gradient;

providing a radio-frequency system which emits RF excitation pulses to excite said nuclear spins and which, under said readout gradient, receives said respective steady state signals; and

operating said radio-frequency system and said gradient coil system to generate a FISP pulse sequence in said volume, said FISP pulse sequence including a plurality of RF excitation pulses separated by respective repetition times, with each repetition time being incremented relative to an immediately preceding repetition time by a phase angle increment, and with respective flip angles $\leq 90^\circ$ that alternate in sign from excitation pulse-to-excitation pulse, so that said steady state signals have respective signal polarities with a relationship selected from the group consisting of identical signal polarities and opposite signal polarities, and wherein said FISP pulse sequence further includes respective phase coding gradients that alternate as to said phase coding direction from repetition time-to-repetition time, and completely balanced gradient pulse trains within each repetition time.

9. A method as claimed in claim 8 wherein said first spin ensemble has a first precession angle associated therewith and wherein said second spin ensemble has a second precession angle associated therewith, and comprising selecting said phase angle increment so that said first and second precession angles satisfy respective mathematical conditions for a selected one of said signal polarity relationships.

10. A method as claimed in claim 8 wherein each of said steady state signals is referenced relative to a zero-axis, and wherein each steady state signal exhibits zero-axis crossings, and comprising selecting said phase angle increment to maximize a difference angle between closest respective zero-axis crossings of the respective steady state signals.

11. A method as claimed in claim 8 comprising operating said radio-frequency system to excite water nuclei as said first spin ensemble and fat nuclei as said second spin ensemble.

12. A method as claimed in claim 8 comprising obtaining and storing a first image dataset when said polarities are identical and for obtaining and storing a second image dataset when said polarities are opposite.

13. A method as claimed in claim 12 comprising generating a pure image of a selected one of said first spin ensemble and said second spin ensemble by combining said first and second image datasets by operations selected from the group consisting of addition and subtraction.

14. A method as claimed in claim 8 comprising generating each phase angle increment as one-half of the phase angle increment of the immediately preceding repetition time.